Assessment Report
For
Department of Mathematics & Statistics

(2013-14 Academic Year)               (December 19, 2013)
(Assessment Period Covered)            (Date Submitted)

Includes Assessment Reports for the Instructional Programs listed below:

<table>
<thead>
<tr>
<th>Title of Degree Program</th>
<th>Degree Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bachelor of Science in Applied Mathematics (Option Applied Mathematics)</td>
<td>Bachelor</td>
</tr>
</tbody>
</table>

Submitted By: ______________  Narendra Kumar Govil, Associate Chair
(Department or Unit Representative)
**Expected Outcomes of this Degree Program:**

*When they complete this degree program, students will be able to . . .*

1. **Numerical Analysis**
   
   When the students complete this degree program, they will be able to demonstrate to have acquired the understanding of the concepts in Numerical Analysis, in topics including, Numerical Analysis, Floating Point System, Solution of Nonlinear Equation, Polynomial Interpolation, and Numerical Integration.

2. **Probability and Stochastic Processes**
   
   When the students complete this degree program, they will be able to demonstrate to have acquired the understanding of the concepts in Probability and Stochastic Processes, in topics including, Basic Concepts in Probability and Stochastic Processes, Conditional Probability, Discrete Distributions, Continuous Distributions, and Joint Distributions.

3. **<Brief description>**
   
   **<Full description>**

4. **<Brief description>**
   
   **<Full description>**

5. **<Brief description>**
   
   **<Full description>**

6. **<Brief description>**
   
   **<Full description>**

*If you wish to record additional expected outcomes, simply cut and paste one of the boxes above.*
NOTE: There should be at least one form C for each expected outcome listed on form B. If you used more than one assessment method to gather information about an expected outcome, there should be one form C for each assessment method. Thus, if you studied three outcomes during the year and used two means of assessment to gather information about each outcome, you would provide a total of six different copies of form C.

Expected Outcome Brief Description:

Students will demonstrate an understanding of concepts in Numerical Analysis, in topics including, Floating Point System, Solution of Nonlinear Equation, Polynomial Interpolation, and Numerical Integration.

Assessment Method, Brief Description:

Common Examination on Items

Assessment Method, Full Description:

The Chair of the department Dr. T.Y. Tam set up an Assessment Committee of the department for the purpose of assessing the programs, comprising of the faculty N.K. Govil (Chair), Ziqin Feng (Co-chair), Dmitry Glotov (Member), Erkan Nane (Member) and Jessica McDonald (Member). This committee then identified some concepts in Numerical Analysis that the committee thought every undergraduate student majoring in Applied Mathematics (Option Applied Mathematics) must know before graduation. Also, this committee helped in making a test having minimum of two questions on each of these concepts, which was then used to find learning outcomes to test the understanding of different concepts in Numerical Analysis, that have been identified by the committee.

The students were given this test towards the end of Fall Semester 2013 in the course on “Numerical Analysis” and the data concerning the performance in these tests was collected and analyzed. The total number of students who took this test for learning outcome “Understanding of Concepts in Numerical Analysis” was 4, and every undergraduate student majoring in Applied Mathematics (Option Applied Mathematics) is required to take this test at some stage because the course where these concepts are covered is a required course for graduation. A copy of the Test is attached with this form.

The data, along with its analysis, concerning the performance in this test is given in the next section, which is on “Assessment Method, Findings”.

Assessment Method, Findings:

In the table given below, the data (and its analysis) is obtained on the basis of test given to students. Test items, 1 and 2, are on the concept, Floating Point System; test items, 3 and 4, are on the concept,
Solution of Nonlinear Equation, and so on. The average proportion of students answering test items 1 and 2 correctly is 100%. See the Appendix 2 for more detailed findings of the assessment.

<table>
<thead>
<tr>
<th>Topics</th>
<th>Test Items Addressing This Learning Goal</th>
<th>Average Proportion of Students Answering These Questions Correctly</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floating Point System</td>
<td>1 and 2</td>
<td>100%</td>
</tr>
<tr>
<td>Solution of Nonlinear Equation</td>
<td>3 and 4</td>
<td>75%</td>
</tr>
<tr>
<td>Polynomial Interpolation</td>
<td>5, 6, and 7</td>
<td>92%</td>
</tr>
<tr>
<td>Numerical Integration</td>
<td>8, 9 and 10</td>
<td>50%</td>
</tr>
</tbody>
</table>

Based on the table given above we find that the students appear to be strong in “Floating Point System” and “Polynomial Interpolation”, not so strong in “Solution of Nonlinear Equation”, while weak in “Numerical Integration”.

**Assessment Method, Use of Findings for Improvement:**

The findings obtained and mentioned in the above section on “Assessment Method, Findings” were discussed with the members of the committee and agreed upon that the instructors teaching these concepts in future will be told of these finding and advised to take measures for correcting this by

(i) Spending more time on the topic “Solution of Nonlinear Equation” and “Numerical Integration”, where students appear to be either not so strong or are weak.

(ii) Provide longer office hours, and encourage students to seek help during the office hours.

Also, the committee will place a request to the department chair to provide some Graduate Teaching Assistants or some other help, so that the students could be provided some extra help in “Solution of Nonlinear Equation” and “Numerical Integration”, where the students are not so strong or weak.

**Any Additional Comments?**

**Appendix 1. Test used for the Assessment:**

Appended below is the copy of the test prepared with the help of the Department Assessment Committee, and used for the purpose of assessment.

.  

Form C
1. For the following 10 questions, solve each problem and decide which of the four choices gives the correct answer.

Given a floating point system \((\beta, t, L, U) = (\beta, t, L, U) = (10, 2, -1, 1)\), where \(\beta\) is the base, \(t\) is the number of significant digits, \(L\) and \(U\) are the lower and upper bound of the exponent respectively. Answer (1) and (2) below.

(1). What is the rounding unit \(\eta\) of this floating point system?
   (A) \(10^{-2}\);
   (B) \(\frac{1}{2} \times 10^{-1}\);
   (C) \(2 \times 10^{-1}\);
   (D) 10.

(2). Which of following four numbers will NOT cause the problem of underflow or overflow if it is represented by the above floating point system?
   (A) 0.11;
   (B) 0.001;
   (C) 100;
   (D) \(-100\).

(3). Which of the following four maps is a contraction map on the interval \([0, 1]\)?
   (A) \(e^{2x}\);
   (B) \(-\frac{1}{2}x\);
   (C) \(\sin(2x)\);
   (D) \(3x^2\).

(4). Which of following four numbers is the fixed point of the nonlinear equation \(x = -x^4 + 2\)?
   (A) 0;
   (B) 1;
   (C) 2;
   (D) 3.

(5). Let \(f(x) = x^3 + 1\). What is the value of the first order divided difference \(f[0, 2]\)?
   (A) 0;
   (B) 2;
   (C) 4;
   (D) 6.
(6). Let \( x_0, x_1, x_2 \) be a set of nodes on \([-1, 1]\). It is known that the value

\[
\max_{-1 \leq x \leq 1} \{ ||x - x_0|| + ||x - x_1|| + ||x - x_2|| \}
\]

achieves the minimum if \( x_0, x_1, \) and \( x_2 \) are the Chebychev points. What are the Chebychev points \( x_0, x_1, \) and \( x_2 \)?

(A) \( x_0 = \cos\left(\frac{\pi}{6}\right), x_1 = \cos\left(\frac{\pi}{2}\right), \) and \( x_2 = \cos\left(\frac{5\pi}{6}\right); \)

(B) \( x_0 = \sin\left(\frac{\pi}{6}\right), x_1 = \sin\left(\frac{\pi}{2}\right), \) and \( x_2 = \sin\left(\frac{5\pi}{6}\right); \)

(C) \( x_0 = -\sin\left(\frac{\pi}{6}\right), x_1 = -\sin\left(\frac{\pi}{2}\right), \) and \( x_2 = -\sin\left(\frac{5\pi}{6}\right); \)

(D) \( x_0 = \cos\left(\frac{\pi}{4}\right), x_1 = \cos\left(\frac{\pi}{2}\right), \) and \( x_2 = \cos\left(\frac{5\pi}{4}\right). \)

(7). Let \( s(x) \) be a cubic spline on the interval \([0, 2]\) that interpolates the data values

\[
\begin{array}{c|ccc}
 i & 0 & 1 & 2 \\
\hline
 x_i & 0 & 1 & 2 \\
 f(x_i) & -2 & 0 & 6 \\
\end{array}
\]

Then which of the following is NOT true?

(A) \( s(1) = 0; \)

(B) \( s(x) \) is a cubic polynomial on \([1, 2]; \)

(C) \( s'(x) \) is continuous on \([0, 2]; \)

(D) \( s''(x) \) is not continuous on \([0, 2]. \)

Answer (8) and (9) below based on the following statement. Let \( x_0, x_1, x_2 \) be a set of nodes on \([0, 1]\), and \( L_0(x), L_1(x), L_2(x) \) be the associated Lagrange basis functions. Consider the approximation of integral \( I(f) = \int_0^1 f(x) \, dx \) by the quadrature formula

\[
L_2(f) = a_0 f(x_0) + a_1 f(x_1) + a_2 f(x_2),
\]

where the quadrature weight \( a_j = \int_0^1 L_j(x) \, dx \) for \( j = 0, 1, \) and \( 2. \)

(8). Assume that the quadrature weight \( a_0 = \frac{1}{4}, a_1 = \frac{1}{2} \) then what is value of the quadrature weight \( a_2? \)

(A) \( \frac{1}{2}; \)

(B) \( \frac{1}{3}; \)

(C) \( \frac{1}{4}; \)

(D) \( \frac{1}{5}; \)
Appendix 2. Table with Detailed Data:

Given below is the table consisting of the data (and its analysis) collected on the basis of scores obtained by the students in the test. In this table, s1, s2, s3, …refer to Student # 1, Student # 2, Student # 3, and so on. For example Student #1 obtained a score of 1 on Question # 1, score of 1 on Question # 2, a score of 1 on Question # 3, and so on, and thus obtaining average of 80% in all the questions. Similarly looking at the first two rows (covered in purple) of the table we find that all the students obtained an average of 100% on the concept of “Floating Point System” (covered by Questions 1 and 2), an average of 75% on the concepts of “Solution of Nonlinear Equation” (covered by Questions 3 and 4), an average of 92% on the concepts of “Polynomial Interpolation” (covered by Questions 5, 6, and 7), and 50% on the concepts of Numerical Integration (covered by Questions 8, 9, and 10). This data has been summarized in the Table given above in the Section on “Assessment Method, Findings”.

<table>
<thead>
<tr>
<th>Questions</th>
<th>s1</th>
<th>s2</th>
<th>s3</th>
<th>s4</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>Floating Point System</td>
<td>100%</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>Solution of Nonlinear Equation</td>
<td>75%</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>Polynomial Interpolation</td>
<td>92%</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>Numerical Integration</td>
<td>50%</td>
</tr>
<tr>
<td>9</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Assessment Report
For

Bachelor of Science in Applied Mathematics
(Option Applied Mathematics)  Bachelor
(Instructional Degree Program)  (Degree Level)

Academic Year 2013-14  December 19, 2013
(Assessment Period Covered)  (Date Submitted)

NOTE: There should be at least one form C for each expected outcome listed on form B. If you used more
than one assessment method to gather information about an expected outcome, there should be one form C for
each assessment method. Thus, if you studied three outcomes during the year and used two means of
assessment to gather information about each outcome, you would provide a total of six different copies of form
C.

Expected Outcome Brief Description:
Students will demonstrate an understanding of concepts in Probability and Stochastic Processes, in
topics including, Basic Concepts in Probability and Stochastic Processes, Conditional Probability,
Discrete Distributions, Continuous Distributions, and Joint Distributions.

Assessment Method, Brief Description:
Common Examination on Items

Assessment Method, Full Description:
The Chair of the department Dr. T.Y. Tam set up an Assessment Committee of the department for the
purpose of assessing the programs, comprising of the faculty N.K. Govil (Chair), Ziqin Feng (Co-chair),
Dmitry Glotov (Member), Erkan Nane (Member) and Jessica McDonald (Member). This committee
then identified some concepts in Probability and Stochastic Processes that the committee thought every
undergraduate student majoring in Applied Mathematics (Option Applied Mathematics) must know
before graduation. Also, this committee helped in making a test having minimum of two questions on
each of these concepts, which was then used to find learning outcomes to test the understanding of
different concepts in Probability and Stochastic Processes, that have been identified by the committee.

The students were given this test towards the end of Fall Semester 2013 in the course on “Probability
and Stochastic Processes” and the data concerning the performance in these tests was collected and
analyzed. The total number of students who took this test for learning outcome “Understanding of
Concepts in Probability and Stochastic Processes” was 9, and every undergraduate student majoring in
Applied Mathematics (Option Applied Mathematics) is required to take this test at some stage because
the course where these concepts are covered is a required course for graduation. A copy of the Test is
appended at the end of this form, as Appendix 1.

The data, along with its analysis, concerning the performance in this test is given in the next section,
which is on “Assessment Method, Findings”.

Form C
Assessment Method, Findings:

In the table given below, the data (and its analysis) is obtained on the basis of test given to students. Test items, 1 and 2, are on the concept, Basic Concepts in Probability and Stochastic Processes; test items, 3 and 4, are on the concept, Conditional Probability, and so on. The average proportion of students answering test items 1 and 2 correctly is 67%. See the Appendix 2 for more detailed findings of the assessment.

<table>
<thead>
<tr>
<th>Topics</th>
<th>Test Items Addressing This Learning Goal</th>
<th>Average Proportion of Students Answering These Questions Correctly</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Concepts</td>
<td>1 and 2</td>
<td>67%</td>
</tr>
<tr>
<td>Conditional Probability</td>
<td>3 and 4</td>
<td>67%</td>
</tr>
<tr>
<td>Discrete Distributions</td>
<td>5 and 6</td>
<td>75%</td>
</tr>
<tr>
<td>Continuous Distributions</td>
<td>7 and 8</td>
<td>89%</td>
</tr>
<tr>
<td>Joint Distributions</td>
<td>9 and 10</td>
<td>61%</td>
</tr>
</tbody>
</table>

Based on the table given above we find that the students appear to be strong in “Continuous Distributions” and “Discrete Distributions”, not so strong in “Basic Concepts”, and “Conditional Probability”, while weak in “Joint Distributions”.

Assessment Method, Use of Findings for Improvement:

The findings obtained and mentioned in the above section on “Assessment Method, Findings” were discussed with the members of the committee and agreed upon that the instructors teaching these concepts in future will be told of these finding and advised to take measures for correcting this by

(i) Spending more time on the topic “Joint Distributions” where students appear to be weak.
(ii) Provide longer office hours, and encourage students to seek help during the office hours.

Also, the committee will place a request to the department chair to provide some Graduate Teaching Assistants who could provide extra help to students in particular to the topic “Joint Distribution”, where the students are weak.

Any Additional Comments?

_______________________________________________________________________
Appendix 1. Test used for the Assessment:
Appended below is the copy of the test prepared with the help of the Department Assessment Committee, and used for the purpose of assessment.

I. Basic Concepts
1. Two events $A$ and $B$ in a sample space are mutually exclusive means that $P(A \cup B) = P(A) + P(B)$. True False
2. Any probability function $P:S \rightarrow [0,1]$ satisfy $P(A \cup B) = P(A) + P(B)$ for any two events $A$ and $B$. True False

II. Conditional Probability
3. Conditional probability is a probability if the given is fixed. True False
4. If two events $A$ and $B$ are independent then $P(A \cup B) = P(A) + P(B)$. True False

III. Discrete Distributions
5. Mean value of a random variable is a measure of center of the values True False
6. Binomial$(n,p)$ mass values converge to Poisson $(\lambda)$ mass values for $\lambda = np$ as $n$ gets large. True False

IV. Continuous Distributions
7. 100pth percentile, $\pi_p$, of a continuous random variable with cumulative distribution $F$ can be obtained by solving the equation $F(\pi_p) = p$. True False
8. Exponential random variable is a special Beta random variable. True False

V. Joint Distributions
9. If the joint density of the random vector $(X, Y)$ is given as a product of the marginal probability density functions, then $X$ and $Y$ are independent. True False
10. Sum of two exponential random variables is exponential. True False
Appendix 2. Table with Detailed Data:

Given below is the table consisting of the data (and its analysis) collected on the basis of scores obtained by the students in the test. In this table, s1, s2, s3, … refer to Student # 1, Student # 2, Student # 3, and so on. For example Student #1 obtained a score of 1 on Question # 1, score of 1 on Question # 2, a score of 1 on Question # 3, and so on, and thus obtaining average of 70% in all the questions. Similarly looking at the first two rows (covered in purple) of the table we find that all the students obtained an average of 67% on the concept of “Basic Concepts” (covered by Questions 1 and 2), an average of 67% on the concepts of “Conditional Probability” (covered by Questions 3 and 4), an average of 75% on the concepts of “Discrete Distributions” (covered by Questions 5 and 6), 89% on the concepts of “Continuous Distributions” (covered by Questions 7 and 8), and 61% on the concepts of “Joint Distributions” (Covered by Question 9 and 10). This data has been summarized in the Table given above in the Section on “Assessment Method, Findings”.

<table>
<thead>
<tr>
<th>Questions</th>
<th>s1</th>
<th>s2</th>
<th>s3</th>
<th>s4</th>
<th>s5</th>
<th>s6</th>
<th>s7</th>
<th>s8</th>
<th>s9</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic Concepts</td>
<td>67%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0.5</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conditional Probability</td>
<td>67%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discrete Distributions</td>
<td>75%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>10</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Continuous Distributions</td>
<td>89%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Joint Distributions</td>
<td>61%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>